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DIVISION OF  
OIL, GAS & MINING

March 5, 1991

Mr. Frank D. Wicks, General Manager  
Barrick Mercur Gold Mine  
P.O. Box 838  
Tooele, UT 84074

Re: January 31, 1991 Barrick Ground Water  
Model Work Plan, Dump Leach Area No. 3,  
Notice of Deficiency, G. W. Permit No.  
UGW450001.

Dear Mr. Wicks:

We have reviewed the above referenced plan, and supplemental submittals of February 6 from Dames & Moore-Denver, and February 13, 1991 from Dames & Moore-Salt Lake City. After careful review and consultation with the U.S. Geological Survey, we have concluded the following issues must be resolved for satisfactory completion of the ground water modeling effort:

1. Section 2.0 Hydrogeologic Setting, p.3 - it appears that more than one-third of the Meadow Canyon drainage area above Dump 3 may effect recharge to the local ground water flow system, due to the fact that all storm water collected by the drainage is impounded on the north and northeast margins of the dump leach and then conveyed under the dump by a perforated pipe. This conveyance is designed to release storm water, under high flow rates, to the underlying alluvium and thereby recharge the uppermost aquifer.
2. Section 3.0 Hydrogeologic Model Parameters
  - A. Principle Fracture and Ground Water Flow Orientation - principle orientation of the fractures and hydraulic conductivity should come from the results of the joint survey (see December 18, 1990 Conditional Approval, Condition 1).
  - B. Extent of Shale Interbeds - comparison of the shale interbeds found in the geologic logs of wells MW-10 and 13 and consideration of the structural dip between the two wells shows that the shale interbeds are not correlative. Therefore, it is unlikely that one or more shale beds extend entirely across the site,

and hence it appears to be more representative to portray these beds as disconnected or lenticular in the domain of the model.

3. Section 4.1 Selection Criteria - we agree that models designed for detailed studies require more hydrologic input data than those models designed for screening studies. The same concept also applies to the dimensionality of models. Three dimensional models require a significantly greater amount of field data (head distribution, transmissivity, storage coefficient, etc.) than do two dimensional models in order to adequately simulate the field environment. This appears to be a significant stumbling block in simulating the local ground water flow and advective transport regime, considering the limited hydraulic and aquifer parameter information currently available for the site. Barrick should evaluate and provide satisfactory consideration to this concern.
4. Section 4.2 Model Selection Results
  - A. Additional Models Not Considered - additional ground water flow and contaminant transport models could have been considered in your elimination process. Many of these are found in the American Geophysical Union Water Resources Monograph No. 5, Groundwater Management: the Use of Numerical Models, 1985, by van der Heijde, et.al. Other models may also be available.
  - B. Dames & Moore Target Model - at this point our limited resources do not allow verification of ground water models generated by proprietary codes or codes that have not undergone comprehensive and satisfactory peer review by the technical community. We have studied the material sent to us by Joanna Moreno of Dames & Moore-Denver and concluded that Dr. Freeze's review appears to be only editorial and did not represent a thorough testing and comparison of the Target model with other accepted models. The USGS (New Mexico) study appears incomplete in that they compared only one run of a 2-D application of Target with an unidentified USGS 2-D model. In addition, the USGS was only able to conduct sensitivity analysis by modifying the USGS model without any comparison of how the same changes would have effected the Target runs. The May 17, 1985 memorandum from EPA-Headquarters has been superseded with subsequent memoranda, one from the same author; both recommend that Target or other proprietary models lacking comprehensive review by the technical community be not accepted (see attached memoranda). To resolve this issue, Barrick must then provide evidence of a comprehensive and satisfactory review of the model by the technical community with satisfactory outcome or select another model by which to simulate the ground water flow and advective transport at the site.

5. Section 5.1 Two-Dimensional Model

- A. Input Data - as required by the December 18, 1990 Conditional Approval, Condition 5, the models must be based on hydraulic properties determined in the field by previous studies, including pump testing. Because the pump testing recently conducted at Dump 3 has been found inconclusive by the Executive Secretary (see February 25, 1991 letter), Barrick is currently unable to provide field measured values for transmissivity and storage coefficient. As a consequence, the ground water flow and advective transport modeling cannot be completed at this time. Barrick must therefore provide these field measured aquifer parameters before the modeling can be completed.
- B. Spatial Variation in Hydraulic Parameters - the model must include spatial variation in the hydraulic parameters. Hydraulic conductivity must decrease vertically in the model from the surface to the water table and horizontally vary due to the major joint sets identified. Storage coefficient must also vary horizontally between the major joint sets and may also decrease vertically in the aquifer.
- C. Hysteresis Curves for Fractured Limestone - simulations of unsaturated flow must be based on known hydraulic conductivity hysteresis curves for fractured limestone or for similar rock media with equivalent bulk and effective porosity. Hysteresis curves submitted by Dames & Moore on February 13, 1991 were not from fractured limestone aquifers, nor did the submittal show how the tested rock material was comparable to the limestone aquifer beneath the dump leach. Barrick must justify how this hysteresis data is representative of the limestone formation found beneath Dump 3 or provide hysteresis data from direct testing of the limestone material found beneath the dump.
- D. Sensitivity Analysis - sensitivity analysis should be conducted by sequentially modifying one input parameter to the model, comparing the results thereof, and continuing this process until all the parameters and permutations thereof have been analyzed. Analysis with unknown or assumed inputs should be run with a range or series of values from most to least conservative, as approved by the Executive Secretary. Analysis with known or measured inputs should also be run with a range of values defined by the precision and accuracy of the measurements. During the course of this analysis, Barrick must construct a matrix summarizing the changes made to the inputs and the resultant output of each run of the model. Best and worst case scenarios can then be drawn from the matrix summary.

6. Section 5.2 Three Dimensional Model

- A. Data for 3-D Model - though the 3-D model is a useful method of conducting and presenting the simulation, we are concerned about the amount of data necessary to make such a model representative of subsurface processes at the facility. Given the sparsity of head distribution, transmissivity, storage coefficient and other hydrologic data at this site, any 3-D model constructed would be subject to a significant degree of assumed inputs, would therefore not represent a unique solution, and will require a significant amount of sensitivity analysis to identify all the possible solutions, including the best and worse case scenarios. We are hopeful however that the number of possible solutions will be limited or significantly reduced by collection of the outstanding hydrologic data, mentioned above. We also anticipate that during the course of the sensitivity analysis all possible aquifer parameter scenarios will be considered. Barrick must also consider and employ all methods available to reduce the uncertainty of the modeling effort, including the collection of additional hydrogeologic data as necessary.
- B. Steady-State and Transient Flow Simulations - based on the water level records in wells at the site it is apparent that steady-state conditions may not exist locally. Consequently, steady-state analysis does not appear appropriate. Transient analysis must not only include leaking conditions from the dump leach, but must also consider rising and falling conditions of the water table and temporal variation in local recharge. This transient model must be matched to the hydrographs of the monitoring wells at the dump leach.

7. General Comments

- A. Scale of Domain - extending the domain of the model to nearby known geologic boundaries will help improve the certainty of results and lessen the need for sensitivity analysis to determine appropriate input parameters. The western edge of the model should be extended to the outcrop of the Long Trail Shale; the eastern edge to the thrust fault juxtaposing the Upper Member of the Great Blue Limestone against the Manning Canyon Shale. Justification must be provided for the location of the northern and southern boundaries of the model.
- B. Definition of Model Boundaries - the plan must define the type of boundary to be assigned to each of the major boundaries in the model. These include the upper, vertical and basal surfaces and the water table surface.

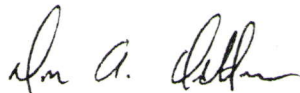
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- C. Single Fracture Conduit - the sensitivity analysis must also evaluate the response of the model to a single fracture conduit capable of conveying the leachate contaminants directly to the water table. This scenario may be simulated by placement of a narrow vertical grid of high vertical hydraulic conductance beneath the permanent process pool in the approximate location of the Meadow Canyon Fault. The model must then simulate the path of the contaminants in the saturated zone.

We suggest a meeting be held with your consultant to discuss these issues. Please contact Loren Morton to arrange such a meeting or to answer any questions or comments.

Sincerely,

Utah Water Pollution Control Committee



Don A. Ostler, P.E.  
Executive Secretary

attachments

LBM:lm

cc: Geoff Freethey, USGS-WRD, SLC  
Grant Bagley, Asst. Attorney General  
David Bird, Parsons, Behle & Latimer  
George Condrat, Dames & Moore-SLC  
Joanna Moreno, Dames & Moore-Denver  
Stephen Matern, Tooele County Health Dept.  
Wayne Hedberg, DOGM  
Glade Shelley, Utah County Health Dept.

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